Appendix C

AM Field Test Procedures and Notes

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1. Introduction & Scope

The National Radio Systems Committee (NRSC) created and released the *IBOC Field Test Procedures—AM Band, revision #6c* in April 2001. The NRSC's document, hereafter referred to as the *NRSC Test Procedure*, is a high level set of test requirements and outline procedures meant to guide iBiquity in field testing its AM IBOC system. This document is a companion to the *NRSC Test Procedure*. Its purpose is to supply guidance and detail to the NRSC test process, aiding the field test engineering team in the setup and execution of the AM IBOC field tests.

This document does not supply all details for every test procedure, but assumes the members of the test team have expertise and experience in the types of procedures described. The test team is expected to follow accepted engineering practices in the execution of the AM IBOC field test plan, including rigorous documentation of the tests.

2. Related Documents

Document	**Author/Organization**	**Notes**
IBOC Field Test Procedures—AM Band, revision #6c	NRSC DAB Sub-Committee	Primary field test document
IBOC Laboratory Test Procedures—AM Band, revision #6c	NRSC DAB Sub-Committee	Lab test document
AM Field Test Route Maps	NRSC DAB Sub-Committee	NRSC version of iBiquity's proposed AM FT routes
DA-98 Digital Multitrack Recorder Owner's Manual	Teac Corporation	Detailed instructions for use and maintenance of the Tascam DA-98
The Collector User Guide	iBiquity Digital Integration & Test	
iView User Guide	iBiquity Digital Integration & Test	

3. Summary Field Test Procedure

3.1 Objectives & Methods

The primary goal of the NRSC's field testing program is to capture simultaneously the over-the-air (OTA) transmission performance of both the digital and analog portions of iBiquity's AM IBOC system, along with associated transmission channel metrics. In practice, the testing team will do this by:

1) setting up Hybrid IBOC transmission systems at agreed upon AM broadcast sites,
2) testing each IBOC broadcast site using a mobile test platform (test van) to sample over-the-air transmissions and
3) delivering the field test data to the designated entities for processing, analysis and archival.

The Hybrid AM IBOC field test program consists of four test segments conducted in and surrounding San Francisco, Detroit and the Washington DC-Baltimore area. In this document, the phrase *test segment* connotes a self-complete suite of tests for a particular IBOC broadcast station.[1] The IBOC station will provide the *desired* signal for most of the test segment and, in the case of compatibility tests, also will serve as an interferer to proximal, adjacent channel analog stations.

3.1.1 The Field Test Observer

The NRSC shall, at its discretion, be allowed to send observers to witness the field test program. iBiquity shall facilitate this by apprising the NRSC of all official field testing with at least two days of advance notice.

The NRSC observers shall be permitted to monitor all official testing activities, but shall not interfere with test procedures. The observer's primary function is test monitoring, however, the observer may actively participate in testing as jointly agreed upon by the observer and iBiquity. In no instance shall the observer require or be required to participate actively in field testing.

3.2 Preparation

To ensure the field testing processes go smoothly and efficiently and also yield valid data, the testing team will carry out a set of pre-test preparations for each test segment.

General field test program preparations are

- Test platform proof-of-performance
    - subsystem tests, including instrumentation function and performance verification
    - system certification test

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[1] In most cases, a group of four to eight radials comprise a test segment. *Test segment* should not be confused with *radial segment,* the later being a subdivision of a single radial.

Test segment-specific preparations comprise

- Verification and configuration of transmission site
  - station analog and digital powers and spectral characteristics
  - program audio, including STL performance and blend parameters
- Verification and configuration of test platform
  - antenna network
  - data acquisition automation
  - EMI/EMC
  - data storage preparation
    - Clearing of DAQ PC hard disk space to accommodate data
    - Formatting of HI-8 tapes for the Tascam DA-98 digital audio recorder
- Review of test procedures
  - segment-specific procedures, i.e., drive routes, timetables and special station operation instructions
  - special test procedures, e.g., host and SCA compatibility tests

This document and its attachments contain both general and test-specific procedures and information for test preparation.

3.3 Execution

The field test team will conduct testing according to the requirements and instructions provided for each test type. Some test segments also may have special instructions. The field test team will observe these for the respective test segments, as well as document any unique circumstances on a segment-by-segment basis.

There are three types of tests – (i) transmitter characterization; (ii) drive testing for coverage and performance of digital and analog AM; and (iii) main channel compatibility testing on both host and adjacent channels. The transmitter characterization takes place at or near the transmission station and includes measurements of Hybrid AM IBOC transmission powers, as well as, transmission spectral characterizations. Most of the remaining tests fall into the drive testing category. These require setting up the mobile test platform's automated test systems and driving prescribed test routes. All test segments contain at a minimum some drive testing of IBOC and host AM.

Host compatibility tests will take place at fixed locations within test station service areas. Host compatibility tests will be conducted for at least two of the test stations. Adjacent channel compatibility will be conducted for three to five non-IBOC, AM stations that are first adjacents to an IBOC test station. In addition, the test team will execute adjacent compatibility tests at two to three non-IBOC, AM stations that are second adjacents to an IBOC test station. The specific stations and procedural details for compatibility tests appear later in this document.

In order to ensure the safety of test data, as well as maintain reasonable data file sizes, the test team will parse each test segment drive route (radial or loop) into sub-routes that may be tested in *one hour or less*. This limitation is critical, as it guarantees the recorded audio will not exceed the length of the digital audio recording media. Secondly, this procedure bounds the extent of data loss should the automated DAQ systems malfunction or a data file be corrupted post-test. Limiting the size of sub-tests also facilitates re-testing and regression testing should either be required.

3.4 Data Recording & Handling

The field test *data acquisition* (*DAQ*) system produces two fundamental classes of raw data – a group of associated PC files in ASCII text, binary and/or JPG formats, and also a Modular Digital Multi-track (MDM) digital audio recording. During testing, the test automation/DAQ software produces and writes the PC data to the test PC's hard disk. The TASCAM DA-98 records the MDM digital audio to metal HI-8 format videotape. At the end of each testing day, the test team will backup test data. PC files shall be copied to a dedicated archival directory on the DAQ PC. If available, this should be to a second, physical hard drive in the PC as opposed to merely another partition of the same physical drive already hosting the original data. The test team also will backup the PC-based data to Iomega ZIP disks.

3.4.1 Manually Recorded Data

Manually recorded data are any data not produced by the test automation applications. Examples of these are recorded audio notes, written notes and printer/plotter plots. All data, whether "official" or "anecdotal" engineering notes will be preserved, as well as, duplicated for backup.

3.4.1.1 Test Segment Notebook

Each test segment shall have a unique notebook or set of notebooks known as the Test Segment Notebook. Wherever possible, all engineering notations about a test segment shall be entered directly into the Test Segment Notebook. The Test Segment Notebook shall be a bound, laboratory or composition-style notebook. Standard laboratory logging and record-keeping procedures shall apply to the Test Segment Notebook. Each page shall be numbered sequentially. As entries are made, each page shall be dated at the top and dated and signed by the authoring engineer at the bottom. No pages shall ever be removed from the notebook. It is to be preserved in its entirety for the test record. No marks that render unreadable any entry shall be made in the test notebook. Errors and changes must be struck out with a single line and initialed and dated by the writer if such changes are significant to recorded data.

3.4.1.2 Test Platform Notebook

Although not required, it is advised that a dedicated Test Platform Notebook be used to document test platform configurations, characterizations, calibrations and proofs.

3.4.2 Data Identification

All data will be identified using the naming conventions substantially similar to those recommended in *Section 6.*

4. Field Preparation

4.1 Transmission Site

4.1.1 Preparation & Configuration

At a minimum, the Hybrid AM IBOC transmission site must be configured with and/or be capable of the following:

4.1.1.1 Studio Transmission Link (STL)

The STL that supplies the audio for digital modulation should support stereophonic audio at a quality greater than or equal to 16 bits-per-channel linear (uncompressed) encoding at a 44.1 MS/s clock rate. The Supervising Engineer shall verify that the STL for the analog (AM) audio signal is in proper working order and delivering the audio performance expected by the station's engineering staff. Any station using an STL that does not meet the prescribed performance may be considered unsuitable for test recording of the received audio programming at the discretion of the Supervising Engineer. In any such a case, analog and digital broadcast audio programming still will be recorded during field tests, however use of that test audio may be restricted as to types of audio evaluation.

4.1.1.2 RF Monitoring Point

To permit transmission line power measurements, the station must have at least one forward power sampling point located after the AM transmitter's final power stage, but prior to any splitting and/or phase adjustment networks for feeding the antenna or antenna array.

4.2 Field Test Platform

4.2.1 Description

4.2.1.1 Hardware

Figure 1 is a high-level block diagram of the field test platform for AM IBOC field testing. The main hardware components of the drive test platform – *the test van* – are:

- the test receivers, both analog and digital
- the spectrum analyzer
- a GPS receiver
- the antennas system
- the controller PC (a.k.a. DAQ PC)
- an 8-Track Modular Digital Multi-Track (MDM) recorder
- a CCD camera

- the van power system
- the van audio monitoring system

The DAQ PC controls the operation of and collects data from all other measurement equipment except the antenna distribution network. The iBiquity Digital IBOC radio, GPS receiver and MDM recorder deliver data to the DAQ PC via RS-232. The spectrum analyzer operates on the IEEE-488 (GPIB) bus. The camera delivers stop-action JPEG images to the PC via an Ethernet network connection.

The camera will not be used for the NRSC Hybrid AM field tests.

As indicated in Figure 1, the AM-band antenna system provides dedicated, 31-inch whip antennas for each test receiver and the spectrum analyzer. Both analog AM test receivers (Delphi and Pioneer) are connected to their respective antennas in a manner similar to a typical vehicular installation. The antenna feeds to these radios consist of standard RG-62 coaxial cable, a type frequently used for automobile installations. RG-62's characteristic impedance is significantly higher than 50 Ω, as its distributed shunt capacitance is relatively low. Because of this, it is better suited as a feed between physically short, electrically capacitive vehicular whips and the high impedance AM receiver front-ends.

Both the iBiquity IBOC receiver and the spectrum analyzer have 50 Ω input impedances in the AM band. As such, they are not electrically compatible with a vehicular whip antenna. To solve this problem, iBiquity has designed a dedicated matching network for AM band testing. This match, connected via a short pigtail to the antenna, converts the antenna feedpoint impedance to 50 Ω. Thus, the output of the match is capable of driving a 50 Ω system – specifically, a 50 Ω coaxial cable and the IBOC receiver or spectrum analyzer.

As shown in the diagram, there is a low noise amplifier (LNA), after the antenna match and just ahead of the spectrum analyzer to improve its sensitivity (noise figure). There are three amplifier models approved for use as an AM-band LNA in this application. The test engineers must document which model is used for each set of field tests in the Test Segment Notebook.

To accommodate the different feeds, matches and amplifiers required for the various receiving devices, each van antenna is connectorized at the end of a short pigtail that extends into the van just below the mounting point. The pigtail is less than 8 inches of RG-58, terminated in a male BNC connector. This allows continuation of the antenna feed into a 50 Ω coaxial cable for use in FM-band testing or connection to an appropriate match or high impedance feed for AM-band testing. Keeping the RG-58 short minimizes the parasitic shunt capacitance in the analog AM receiver application.

The test receivers are discussed in Section 5.

4.2.1.2 Test Automation Software

The test automation software, *The Collector*, is a stand-alone, executable program created by iBiquity using National Instruments' LabView development system. *The Collector* runs under Windows 98 or Windows 2000 on the DAQ PC. *The Collector* is capable of complete control of the performance elements of IBOC field testing. *The Collector* can query and/or control an Agilent HP8591E spectrum analyzer, a Tascam DA-98, a Trimble Placer 455 GPS receiver, iBiquity IBOC receiver and a networked JPG image camera server.

The Collector is the successor to *TakeATest*, the DAQ software used in the FM portion of the NRSC's IBOC test programs. iBiquity has carried forward to *The Collector* many of *TakeATest*'s principles of operation. *The Collector* advances beyond *TakeATest* in featuring a more intuitive and comprehensive graphical user interface (GUI), additional data export capabilities and enhanced test system diagnostics.

Attachment A is a screen shot of *The Collector* main screen GUI.

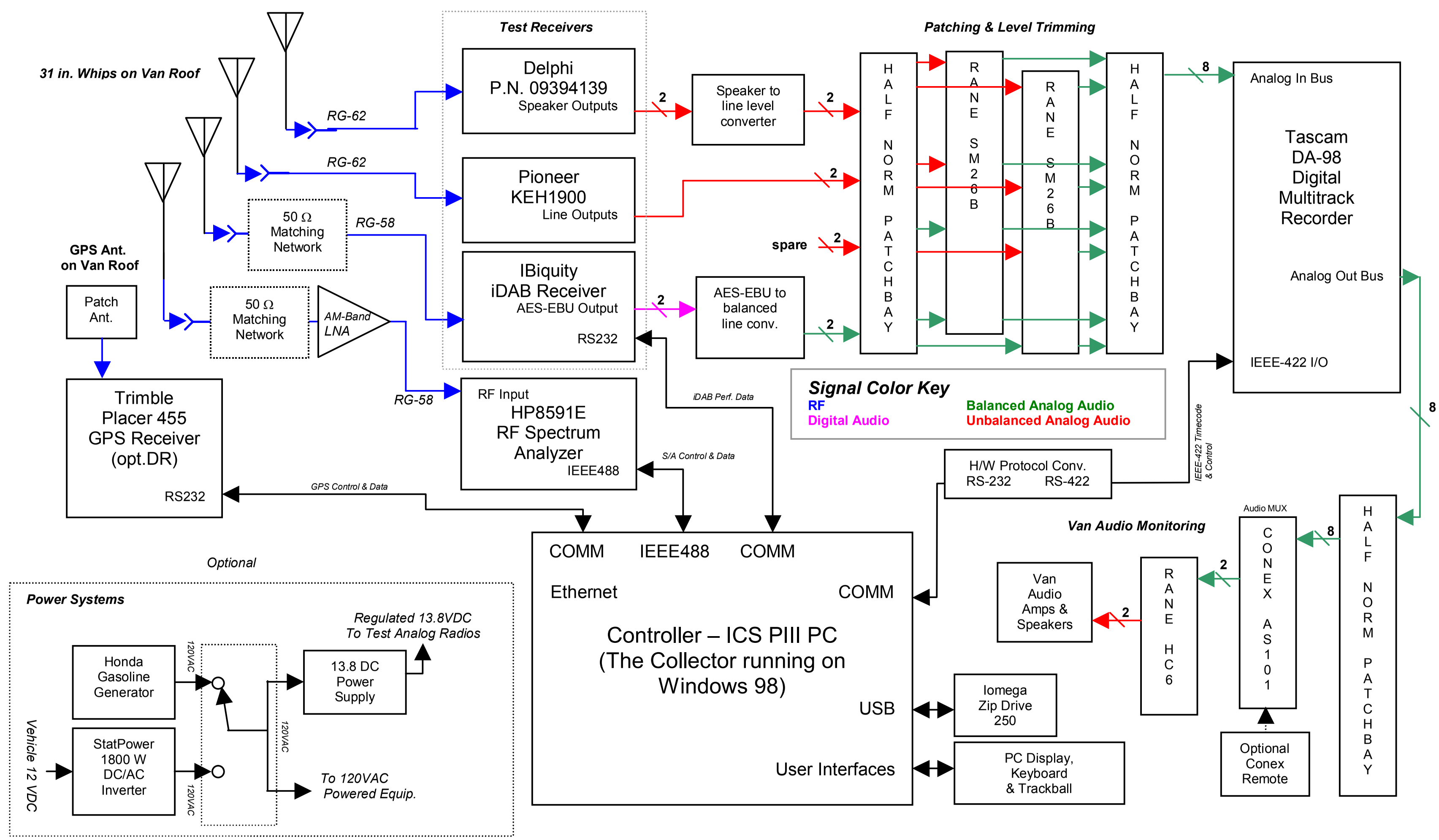

Figure 1: Mobile Test Platform Generalized Block Diagram

4.2.2 Preparation

4.2.2.1 Test Receivers

4.2.2.1.1 Pre-Test Characterization & Set-up

4.2.2.1.1.1 Analog Receivers

All AM test receivers require pre-field test characterization as specified by the NRSC. NRSC sponsor CEA has arranged for receiver characterization testing with an independent laboratory. Each characterized receiver will bear an identification number. This identification number shall be recorded with the field test data so field performance of any analog receiver may be corroborated and/or compared to its laboratory characterization.

Specific characterization testing information is available in documents located on the NRSC's website.

4.2.2.1.1.2 Digital Receiver

Each iBiquity digital receiver will be characterized and declared ready for testing prior to any field testing. No changes to a digital receiver shall be permitted during field testing unless authorized by the field test Engineering Manager or Program Manager. Test data and an explanation of modifications or repairs must accompany any changes that are made.

4.2.2.2 Test Van Subsystem Characterization & Proofs

The test team must conduct mobile test platform (test van) subsystem characterization and proofing at least once during the field test program to ensure proper configuration and performance of the measurement components. Should any subsystem be altered or replaced during the course of the field test program, that subsystem and any other affected subsystems must be re-proofed. It is recommended that test van subsystem proofing be done *prior to* the first official field test done with a mobile test platform. This will eliminate the need for re-testing of a test segment should the subsystem proof indicate questionable test van performance.

Periodic re-proofing of the mobile test platform subsystems is advised to ensure consistency of measurement performance. All proof data shall be logged in a laboratory notebook, preferably the Test Platform Notebook.

The remainder of this subsection describes recommended methods for test van characterization and proofs. However, at the discretion of the senior technical members of the test team, other methods may be used and, if so, documented in the Test Platform Notebook.

4.2.2.2.1 Antenna System Tests

The Hybrid AM field test platform uses multiple receiving antenna system. While the antennas are not identical due to differences in location on the van roof, they should exhibit substantially similar performances in the AM band. Several basic checks of the antenna system performance should ensure that each receiver or test instrument is receiving a substantially similar signal as all other receivers and instruments. A primary proof of this is a demonstration that the relative sensitivities of the receiver models, as characterized in the laboratory, are maintained in the field. This is, however, only valid in the absence of in-band noise and interference.

Antenna equivalency also can be demonstrated if the relative receiver performances are maintained as receivers and test platform antennas are interchanged. For greater validity, this should be done in a variety of reception conditions. One of these conditions must include weak desired signal with very low AM-band noise and interference. To compare directivity of the various antennas, the antenna/receiver interchange tests should be performed with the test van's position rotated so antennas are tested from different azimuth angles.

> *Note: When doing receiver/antenna interchange comparisons, all feed cables types (i.e., impedances), matches and amplifiers (for the spectrum analyzer) must remain with their respective receivers or instruments*. That is, swapping antennas should be done at the antenna pigtailed connections, with matches, amplifiers and feeds staying paired with their test receivers.

The antenna, match, low noise amplifier and feed cable for the spectrum analyzer may be calibrated and checked for repeatability using a field-intensity-meter (FIM). Use of an FIM is intrinsic to the field compatibility tests. Therefore, collection of spectrum analyzer levels and field intensity readings during the compatibility tests are a recurring opportunity to verify performance of the spectrum analyzer antenna system.

4.2.2.2.2 GPS System Tests

The test team will locate the Drive Test Platform at a position of known geographical coordinates. The platform's GPS receiver shall provide the correct latitude and longitude with an error of less than 20 meters. GPS operation also may be verified using DeLorme Street Atlas or iBiquity's iView program to plot test route data against a known good map.

4.2.2.2.3 Spectrum Analysis

Using an RF signal source, the test team will inject a set of RF test signals into the input of the antenna network to test the spectrum analysis operation. All modes of spectrum analysis used in testing shall be checked to verify the analyzer never is forced into uncalibrated operation.

4.2.2.2.4 Audio Recording Subsystems Tests

The audio recording subsystems shall be examined to ensure balanced, distortion-free recording of all audio channels for each radio-under-test. In particular, silent passages in recorded material from each audio source (radio) shall be checked for the presence of noise and hum. Residual hum and noise shall be no greater than –90 dB relative to full scale, A-weighted RMS, or –80 dB relative to full scale, A-weighted Quasi-Peak measured from the point of audio signal input (from the test radios) to recorded digital audio tape. If tests are made using a reference level below full scale, the required performance is de-rated by the decibel difference between full scale and the test reference level. For example, if the test reference level is –12 dBFS, then the maximum residual hum and noise shall be –78 dB A-weighted RMS or –68 dB A-weighted Quasi-Peak. This test does not include noise produced by the test radios nor apply to the in-van audio monitoring system after the DA-98 digital audio recorder. The recommended instrument for this test is the Audio Precision model System I (or System II) equipped with A-weighted audio filtering and Quasi-Peak velocity metering.

4.2.2.2.5 Data Logging Tests

The automated field testing program, *The Collector*, shall be checked for proper data acquisition and storage. To do this, two verification steps are prescribed:

- Examine the data display capabilities of *The Collector* in the pre-recording mode. The control panel of *The Collector* displays indicators for all data recording modes that are active. The test engineers should be able to verify acquisition of GPS data, spectral data and digital radio state and data.
- Initiate *The Collector* recording mode and store test data to a file. After storage of several cycles of test data, end the recording mode. Using a text editor, open the data file and manually verify that contents of the file include all forms of data and that these data match the test conditions during the recording. Using *The Collector*'s export feature, a data file may be converted to a tab-delimited text file containing GPS and radio performance data. In this format, it is possible to import lat/lon-keyed data into a PC-based mapping program, such as Delorme Street Atlas for review.

  Alternatively, the raw data file, directly from *The Collector* may be "played back" using iBiquity's iView program.

4.2.2.2.6 Electromagnetic Interference Checks

Each mobile test platform, including the van, instrumentation, power sources and the test radios themselves must undergo testing for generation of EMI that may cause degradation to the performance of the test radios. This testing is usually done in several steps. The first step is to check the AM band for the presence of interference using a spectrum analyzer connected to the van antenna. Unfortunately, spectrum analyzers do not possess the same sensitivity (low noise figure) as the receivers being tested. This test will identify only the more blatant EMI offenders.

Two approaches to enhancing spectrum analyzer EMI testing capabilities are possible – the addition of an LNA before the spectrum analyzer's RF input and the use of a close-field probing antenna. The former method will lower the spectrum analyzer's effective noise floor, making it much more sensitive to low-level signals and interference. However, the analyzer may not yet be sensitive enough to “hear what the radio hears.” Using a close-field probe will not actually increase the analyzer’s sensitivity, but it will facilitate the isolation of each potential radiated interference source in the van. This helps lead to clear identification of any and all AM-band emitters. Assiduous observation by this method will usually reveal all *potential* interferers, but many of these will have no significance to the receivers’ performances. The importance of close field probing is the ability to absolutely identify all in-band EMI generators.

After identifying potential interferers, the next step is to evaluate the effect each has upon receiver operation. The team can best do this by testing in an edge-of-coverage over-the-air signal situation and monitoring receiver performance parameters (e.g., audio quality and/or block-error-rates) as each potential in-band emitter is turned *ON* and *OFF* one at a time. Note: this test *must* be done over-the-air. Testing over a coaxial connection between a transmitter and the target receiver is not a critical, real world test, as most in-field EMI problems are the result of radiated, *not* conducted interference.

If threshold sensitivity of any radio – analog or IBOC – is degraded by more than 1 dB with all van equipment *ON* versus all van equipment *OFF* (except radio-under-test, preferably DC power source and audio test gear), then it is likely EMI remediation will be necessary. A measurable loss of full audio quality[2] in any test radio due to van instrumentation or power supply operation also may indicate EMI degradation. Attachment B discusses EMI remediation. Sensitivity of an analog AM radios typically is benchmarked as the antenna input signal level versus some measure of desired signal-to-noise ratio. For the iBiquity digital radio, sensitivity is defined as the RF signal level required for a predetermined BLER performance. For a comparative measure of sensitivity, it is recommended that

- Analog receivers should be tested for RF input level to achieve a 40 dB (RMS) audio signal-to-noise ratio or a 30 dB (AWQP[3]) audio signal-to-noise ratio. If the sensitivity is done using analog receivers, it is probably only possible to make the measurement using a local, low powered AM transmitter in order to be able to control the audio modulation. This is difficult measurement to conduct, as it must be done in an area of extremely low RF background noise.
- The digital receiver should be tested for RF input level required to achieve a fixed modem block-error-rate of 1 to 10%. As with an analog receiver, digital receiver testing must be done in an area of low RF background noise. But unlike the case of the analog test signal, the digital transmitter modulation may be used without any host analog or digital channel content change, making this method more easily executed in the field.

Finally, if the sensitivity of the spectrum analyzer does not seem to reveal any EMI, yet all other signs indicate in-band, self-interference, two things may help: The first is to

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[2] Assessing the severity of audio quality loss is left to the professional judgment of the test team.

[3] **A**-**W**eighted, **Q**uasi-**P**eak, a combined filtering and metering ballistics setting that better represents human audio perception.

monitor the IF signal of one of the receivers to see if the interference is visible there. If so, proceed to switching local equipment *ON* and *OFF* to identify the EMI offenders. The second is to do a wideband spectral analysis on the signal from the antenna to determine the possibility of intermodulation interference.

4.2.2.3 Mobile Test Platform System Certification

The goal of mobile test platform certification is to ensure all radio receivers perform to expected levels when installed in the test van along with the entire suite of required test and measurement instrumentation. To this end, the following procedures are recommended to guarantee proper system performance of the mobile test platform and radios. Equivalent tests are acceptable. All mobile test platform system certification tests use coaxial-cabled RF test signal injection.

Mobile Test Platform System Certification will be conducted using all receivers that will be connected to the van's antenna system and/or power supply.

4.2.2.3.1 Analog Receiver Tests

The analog receiver tests demonstrate that test van installation does not significantly alter the performance characteristics of the test radios as compared to the laboratory environment. These tests ensure mid-level signal performance of the van's RF distribution network and audio signal path integrity from each receiver's audio to the digital audio recorder. The test engineers will set up an AM transmission test set to provide an RF level of approximately 0.175 mV RMS[4] to each analog radio under test. The AM transmission tester shall be for 100% of the FCC-permitted modulation.

An audio analysis test set such as the Audio Precision System II is recommended as a coupled audio source and measurement system for the analog receiver tests. Using an System II or equivalent and an AM modulation transmission test set, the following tests shall be conducted:

4.2.2.3.1.1 Audio Hum and Noise

A-weighted, quasi-peak and A-weighted, RMS measurement of received audio. Modulation reference is a 1 kHz tone at 100% permitted modulation

4.2.2.3.1.2 Audio Total Harmonic Distortion and Noise

A-weighted, quasi-peak and A-weighted, RMS measurement of received audio. Tested channel modulation reference is a 1 kHz tone at 100% permitted modulation.

4.2.2.3.1.3 Digital Receiver Tests

The digital receiver shall be tested in both analog and digital modes. The analog mode tests shall be conducted in the same manner in which the analog receivers are tested. That is, by use of an AM transmission test set and an audio analysis test set in the manner

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[4] This is approximately –62 dBm into a 50 Ω through-termination at the input of an automobile receiver. The through-termination ensure a 50 Ω signal generator is properly terminated while driving a high impedance AM receiver input.

described in section 4.2.2.3.1 above. In order to ensure the digital receiver is in analog reception mode, an analog-only RF test signal shall be supplied to the receiver.

Digital mode tests may be conducted using test signals from the IBOC exciter. The hybrid signal will be injected into the antenna distribution network and received by the digital receiver via its designated port.

4.2.2.3.1.4 Analog Mode AM Audio Hum and Noise

A-weighted, quasi-peak and A-weighted, RMS measurement of received audio. Tested channel modulation reference is a 1 kHz tone at 100% permitted modulation.

4.2.2.3.1.5 Analog Mode AM Audio Total Harmonic Distortion and Noise

A-weighted, quasi-peak and A-weighted, RMS measurement of received audio. Tested channel modulation reference is a 1 kHz tone at 100% permitted modulation.

4.2.2.3.1.6 Digital Mode Block-Error-Rate

Hybrid IBOC RF level injected at the input of the antenna distribution network versus receiver block-error-rate (BLER), as read from the receiver. Recommended tests are: long-term BLER at a –62 dBm hybrid signal RF input to check for irreducible error rate (also known as error leakage) and RF level versus BLER for BLER near 1% and 10%.

4.3 Calibration of Test Equipment

All test equipment that is part of the IBOC station or mobile test platform or used to test any systems or components of either shall be calibrated to acceptable test and measurement industry standards. Specifically, all equipment that is subject to calibration cycles shall be maintained per the manufacturers' requirements. Each item of such equipment must bear a calibration label evidencing valid and current calibration status. No piece of test equipment that is due for calibration or has no evidence of proper calibration status may be used for official measurements. Further, any piece of test equipment subject to a calibration schedule shall be re-calibrated if exposed to extreme physical or electrical conditions that could possibly alter that instrument's measurement accuracy.

5. Field Test Execution

5.1 Station Characterization

5.1.1 Digital-to-Analog Power Ratio

Unlike iBiquity's Hybrid FM transmission system, which uses RF power combining to mathematically add the analog and digital transmission signals, a single Hybrid AM exciter produces both the AM analog and digital IBOC signals. The Hybrid AM IBOC exciter completely controls the IBOC digital-to-analog power ratio. In fact this ratio is not easily user-programmable, but is a fixed parameter defined in the Hybrid AM IBOC exciter firmware. Therefore, it is unnecessary for the field test engineers to adjust the digital-to-analog power ratio. This parameter need only be measured.

5.2 Station Characterization

The *NRSC Field Test Procedures* parts A1 through and including A3 address station characterization, both initially and on a daily basis.

5.2.1 Initial Characterization

5.2.1.1 Analog Power (NRSC Test Procedure A.1.1)

The station's analog transmission power shall be read from the station's existing power monitoring equipment and recorded. The IBOC digital signal shall be ***off***. The analog power may be recorded as either the power of the unmodulated carrier or the average power of the modulated carrier; *however, the test team must note the state of modulation for this measurement*.

5.2.1.2 Digital Power (NRSC Test Procedure A.1.2)

The station's digital power shall be recorded using a spectrum analyzer connected to an appropriate point in the station transmission path. The spectrum analyzer parameters shall sample the signal from the station's monitoring point at the output of the AM transmission system. The digital power levels for each IBOC digital signal group are measured relative to the analog host average power. Therefore, this measurement records values of the Hybrid AM IBOC signal power spectral density at points in both the analog and digital portions of the spectrum.

Six to eight spectrum analyzer plots shall be made as specified in Table 1. The tertiary digital bands are located "beneath" the analog signal in the AM IBOC spectrum (carrier frequency ± 5 kHz). If the analog modulation cannot be turned off during this test, then it is unnecessary to make measurements in the tertiary digital bands, as the analog modulation will mask the tertiary digital signal.

Alternatively, digital (and analog) power may be measured using a vector signal analyzer.

Meas. No.	Marker Mode & Location	Center Freq.	Span (kHz)	RBW	VBW	Video AVG	Comment
A.1.2.a	Noise Marker **OFF** CF	Station Carrier	50 kHz	30 kHz	3 kHz	100	Analog reference power: record marker value in dBm
A.1.2.b	Noise Marker **OFF** CF	Station Carrier	50 kHz	10 kHz	3 kHz	100	Analog reference power: record marker value in dBm
A.1.2.c	Noise Marker **ON** CF-12.5 kHz	Station Carrier	50 kHz	300 Hz	300 Hz	100	Lowside primary digital: record marker value in dBm/Hz
A.1.2.d	Noise Marker **ON** CF+12.5 kHz	Station Carrier	50 kHz	300 Hz	300 Hz	100	Highside primary digital: record marker value in dBm/Hz
A.1.2.e	Noise Marker **ON** CF-7.5 kHz	Station Carrier	50 kHz	300 Hz	300 Hz	100	Lowside secondary digital: record marker value in dBm/Hz
A.1.2.f	Noise Marker **ON** CF+7.5 kHz	Station Carrier	50 kHz	300 Hz	300 Hz	100	Highside secondary digital: record marker value in dBm/Hz
A.1.2.g	Noise Marker **ON** CF-2.5 kHz	Station Carrier	50 kHz	300 Hz	300 Hz	100	Lowside tertiary digital: record marker value in dBm/Hz – only measurable with no analog modulation
A.1.2.h	Noise Marker **ON** CF+2.5 kHz	Station Carrier	50 kHz	300 Hz	300 Hz	100	Highside tertiary digital: record marker value in dBm/Hz – only measurable with no analog modulation

Table 1: Parameters for Digital Power Spectral Measurements

5.2.2 Station Modulation Characterization (*NRSC Test Procedure A.3*)

The test team shall record the station's averaged and peak-hold (max-hold) analog power spectral densities as detailed in Table 2.

Meas. No.	DAB Mode	Center Freq.	Span (kHz)	RBW	VBW	Video AVG	Trace Max Hold	Comment
A.3.1.a	DAB **OFF** (Analog only)	Station Carrier	50 kHz	300 Hz	300 Hz	100	**OFF**	Analog signal average PSD
A.3.1.b	DAB **OFF** (Analog only)	Station Carrier	50 kHz	300 Hz	300 Hz	**OFF**	10 minutes	Analog signal peak hold PSD

Table 2: Initial Characterization of Station Analog Spectrum

5.2.3 Daily Station Measurements

Spectrum and the field over-the-air (OTA) measures shall be collected daily as below. Although not required by the NRSC procedure, it is recommended that the test team perform analog and digital power station measurements (Section 5.2.1, above) at the beginning of each test day (or night, after pattern/power changeover).

5.2.3.1 Daily Spectrum (NRSC Test Procedures A.2)

The test team shall perform the daily spectral measurements at the station transmission sample point using the spectrum analyzer setup parameters in Table 3.

Meas. No.	**DAB Mode**	**Center Freq.**	**Span (kHz)**	**RBW**	**VBW**	**Video AVG**	**Trace Max Hold**	**Comment**
A.2.a	DAB **ON**	Station Carrier	100 kHz	300 Hz	30 kHz	**OFF**	**10 minutes**	
A.2.b	DAB **OFF**	Station Carrier	100 kHz	300 Hz	30 kHz	**OFF**	**10 minutes**	

Table 3: Daily Spectrum Measurements

5.2.3.2 Field over-the-air spectrum (NRSC Test Procedures – no reference)

In addition to the station measurements, the test team shall plot the over-the-air Hybrid AM IBOC spectrum from a location between 1 and 5 miles from the transmitter site. When compared to station measurements, this plot will show the effect the transmission transmitter-antenna match, feed network and antenna have on the IBOC signal. This measurement should be taken from the test van using the roof antenna system and spectrum analyzer. The spectrum analyzer setup parameters appear in Table 4.

Meas. No.	**DAB Mode**	**Center Freq.**	**Span (kHz)**	**RBW**	**VBW**	**Video AVG**	**Reference Level**	**Comment**
--	DAB **ON**	Station Carrier	100 kHz	300 Hz	300 Hz	**100**	5 to 10 dB above received carrier level	

Table 4: Daily Field OTA Spectrum Measurement

5.3 Performance Tests

5.3.1 Test Stations & Routes

Stations WTOP, WD2XAM, WWJ and KABL are the official NRSC Hybrid AM IBOC field test stations. The NRSC's *AM Field Test Route Maps* Document specifies test routes for each.

Each drive test route shall begin within 2 miles of the IBOC transmission site wherever possible. The standard direction of travel will be away from the transmitter, and each radial shall continue past the edge of digital coverage. The edge of digital coverage will be considered the point past which the IBOC radio remains substantially in analog mode. If possible, the radial shall continue to loss of digital synchronization.

Each station shall be tested for both daytime and nighttime performance, using the NRSC test routes.

5.3.2 Performance Test Radios

In addition to the iBiquity digital receiver, the audio from two additional test receivers will be recorded during field testing. These are:

- Delphi PN 09394139 original equipment automobile receiver
- Pioneer model KEH-1900 aftermarket automobile receiver

As noted in the *Field Test Platform* section, above, each analog receiver used in the field tests must be pre-tested and characterized for performance in cooperation with CEA. Each analog test radio shall be securely installed in the test van and connected to one of four, 31-inch whip antennas by way of RG-62 coaxial cable.

The digital radio shall be characterized by iBiquity and connected to its dedicated 31-inch whip antenna through an iBiquity AM-band antenna matching network and a 50 Ω coaxial cable. The match must be located as close as possible to the antenna for best operation, that is, connected directly to the whip antenna's pigtail connector.

5.3.3 Test Configuration, Launch & Monitoring

Detailed instructions for the use of *The Collector*, the Tascam DA-98 and all other field test platform instruments appear in their respective owner and/or user guides. It is assumed that members of the test team are familiar with the proper operation and maintenance of each component of the field test platform.

These steps shall be followed to start data acquisition for a field test segment:

1. Power up all equipment mains (120 VAC and 12 VDC) and turn on all van test equipment. Allow all equipment to warm-up at least 30 minutes.
2. If not already done, complete Windows 98/2000 boot-up of the DAQ PC.
3. Set all test radios to the desired frequency. Set volume controls on each radio to between 70% and 90% of full scale. Set all tone control to neutral (mid-value or center detent). Turn off any loudness equalization (On the Pioneer KEH-1900, do this by depressing the *SHIFT/LOUD* button until the display's loudness indicator is *off*.)
4. Set the Tascam DA-98 to input monitor mode using by depressing the *input monitor* buttons below each level meter or depressing the *all input* button. The orange LED below each monitored channel should be lit. Make sure the Tascam is loaded with a Hi-8 digital audiotape that is pre-formatted at a 44.1 kHz sample rate (kS/s). Arm the DA-98 for recording by depressing the *record function* buttons below each level meter corresponding to each channel to be recorded. A

red LED will light for each channel armed to record. Generally, two channels per test radio will be armed, corresponding to left and right audio for each.

5. While receiving the desired station, adjust the Rane SM-26B audio trimmers so that the audio levels from each radio – both analog and digital – peak at –9 dB relative to full scale on the Tascam DA-98.
6. Start *The Collector* on the DAQ PC. This will launch *The Collector*'s start-up screen. Set the states of the instruments according to Table 5. *The Collector* should indicate *Found* status for all instruments except the camera, which will not be used in AM testing. Any instruments configured for operation, but not communicating with *The Collector* will produce a *Not Found* status (red). These instances should be corrected. When all instruments are properly indicated click the *Run Program* button.

Instrument	**State**	**Status Indicator**
Receiver	Present	Found (green)
Spectrum Analyzer	Present	Found (green)
GPS	Present	Found (green)
Camera	Not Present	Not Found (gray)
SMPTE Time	Present	Found (green)

Table 5: Collector Start-up Screen Settings

7. *The Collector* will open its main screen. For AM field testing there will be only one measurement loop and, therefore, only a single set of test configuration parameters. To set up a test, select *Configure Test* from *Configuration* menu in *The Collector's* main screen. Configure *The Collector* as shown in Table 6.

   If the correct test station is not available from the station list in the *Configure Test* menu, it may be added using the *Configure Station* menu located in the main screen's *Configuration* menu.

Test Parameter	Value	Units	Comment
Test Name	As Required		Test name should include station call letters, radial ID and segment, direction of radial and retest index (similar to file name)
Station	As required, from pop-up menu		Select from pop-up menu to set center frequency and load transmitter geographical coordinates
Center Frequency	As required	MHz	Note: enter in MHz, not kHz
Span	100	kHz	
Reference Level	As required	dBm	Recommended starting level is –10 to –20 dBm
Auto Level Change	Off		Only *Off* currently available
RBW	1	kHz	
VBW	1	kHz	
Attenuation	Auto		Only *Auto* currently available
Video Averaging	Off		Only *Off* (=1) currently available
Loops	1		
Number of Tests	1		
Loop by Time/GPS	Time		Only *Time* currently available
Loop time/distance	5	sec.	

Table 6: The Collector's Test Configuration Parameters

8. Begin audio recording on the DA-98 by simultaneously depressing the record and play buttons.
9. After all devices are confirmed operational and the test set up is complete, initiate recording of the test segment by clicking the *Start Recording* button on *The Collector*'s main screen. Enter the file name to which test data will be stored in the Windows file box. Click on *Save* to close the file box and begin data recording.
10. During recording, a test operator must monitor the test environment to adjust the spectrum analyzer reference level and insert hot key comments to indicate significant propagation conditions. These are discussed in the section *Hot Key Entries* below.
11. At the end of the test segment, click the *Stop Recording* button on *The Collector* main screen. This will end data recording and close the data file.
12. Depress the stop button on the DA-98 to end audio recording.
13. The completed data file and recorded digital audiotape shall be labeled and processed as described in the section *Data Handling*, below.

5.3.3.1.1 Hot Key Entries

During the recording of field test data by *The Collector*, the test operator is responsible for some manual control and data entry. The signal powers of the desired and nearby adjacent channels will vary by tens of decibels over most drive test routes. Therefore, it is necessary to adjust the spectrum analyzer's reference level periodically for best signal capture within the analyzer's dynamic range. *The Collector*'s main screen has two buttons to permit manual spectrum analyzer reference level adjustment manually during test execution. The buttons labeled *–10 dB Ref (Ctrl – F9)* or *+10 dB Ref (Ctrl –F10)* lower or raise, respectively, the value of the spectrum analyzer's reference level by 10 dB per actuation. The test operator shall monitor the signal levels as captured by the spectrum analyzer and make adjustments accordingly.

The Collector also provides a set of hot keys to insert observational notes in the data file. Using the hot keys, the test operator shall note specific environmental conditions that may impact radio performance as those conditions occur.

Table 7 list hot key assignments.

Hot Key	**Action**	**Comment**
F1	Inserts "***Overpass***" comment in data file	
F2	Inserts "***Overhead Signs***" comment in data file	
F3	Inserts "***Power Line***" comment in data file	Use when crossing under power lines.
F4	Inserts "***Trucks***" comment in data file	
F5	Inserts "***Buildings***" comment in data file	
F6	Inserts "***Tunnel***" comment in data file	
F7	Inserts "***Bridge***" comment in data file	
F8	Inserts "***Lightning***" comment in data file	
End	Inserts "***Ignore last comment***" comment in data file	Used to cancel erroneous entry.
Page Up	Inserts "***Large sound impairment***" comment in data file	Generally used for impairments heard in analog radio audio.
Page Down	Inserts "***Small sound impairment***" comment in data file	Generally used for impairments heard in analog radio audio.
Ctrl – F9	Changes Spectrum Analyzer Reference Level by **-10 dB**	Use when largest spectrum analyzer signal is 30 dB or more below reference.
Ctrl –F10	Changes Spectrum Analyzer Reference Level by **+10 dB**	Use to keep largest spectrum analyzer signal at least 10 dB below reference level.

Table 7: *The Collector* Hot Key Assignments

5.4 Compatibility Tests

All compatibility tests will be conducted from fixed locations in the field. The full suite of compatibility testing includes host compatibility, 1st adjacent channel compatibility, 2nd adjacent channel compatibility and, given time and opportunity, 3rd adjacent channel compatibility.

5.4.1 Host Capability

Host compatibility tests are to be conducted for all four AM test stations: WTOP, WD2XAM, WWJ and KABL. For host compatibility, measurements are to be made at three locations in each station's coverage area that exhibit strong, interference-free reception to maximize the analog audio quality received by the test radios. At each location, received signal strength shall be recorded using an AM-band field intensity meter.

For all test receivers, host compatibility digital audio recordings shall be made of station reception with and without the DAB portion of the IBOC signal. During DAB transmission, it is required that the analog host bandwidth be limited to 4.5 kHz to avoid interference with some components of the DAB signal. If possible, the AM analog bandwidth should be expanded to the full 10 kHz during DAB-off periods. In both DAB-on and DAB-off conditions, NRSC pre-emphasis shall be use on the host AM audio if permitted by the station management.

Each recording shall capture 30 seconds of received station analog audio with DAB *on*, followed by 30 seconds of received station audio with DAB *off*. This cycle shall be conducted ten times. If DAB-off is executed for *both* 4.5 kHz and 10 kHz host audio bandwidth, then the testing cycle will be 30 seconds of DAB-on, 30 seconds of 4.5 kHz DAB-off and 30 seconds of 10 kHz DAB-off per condition and executed for ten, complete cycles. If required, extra steps for mode switching may be added to the test cycle and noted in the test documentation. The test operator must carefully record DAB-on/off timing and the associated transmission mode.

For each host compatibility location, the test operator shall record two, averaged spectral sweeps to document RF channel conditions. Table 8 contains the settings for each plot.

> *Note: The full-band sweep is a check for strong signals anywhere within the AM band that may compromise the testing by degrading baseline receiver performance. Should the full-band sweep of any compatibility test location reveal one or more high level signals that might cause receiver overload or intermodulation degradation, the test must be relocated to another, more RF-hospitable site.*

Meas. Type	Center Freq.	Span (kHz)	RBW (kHz)	VBW (kHz)	Video AVG	Reference Level	Sweep Time
Close-in Spectral Occupancy Sweep	IBOC Station Carrier	100	3	3	25 to 100	As required	Auto
Full-band Spectral Occupancy Sweep	1.125 MHz	2000	3	3	25 to 100	As Required	Auto

Table 8: Spectrum Analyzer Settings for Compatibility Measurements

5.4.2 Adjacent Channel Compatibility

5.4.2.1 1st Adjacent Channel Compatibility

1st adjacent compatibility will be tested for stations WTOP and KABL. The procedure for 1st adjacent compatibility is essentially the same as for host compatibility except that the desired station in each test will be an analog AM station to which one of IBOC stations (WTOP or KABL) is a 1st adjacent. The test D/U ratios for 1st adjacent compatibility tests will be 10 dB, 15 dB and 20 dB. *Note that this means the IBOC station will be lower in power than the desired AM station*. The powers of the desired and the IBOC interfering station shall be measured using both the spectrum analyzer and the field intensity meter. Spectrum analyzer settings appear in Table 8.

The desired station audio shall be recorded for ten, complete cycles of 30 seconds of DAB *on* followed by 30 seconds of DAB *off.* As for host compatibility, the NRSC pre-emphasis will be used on the IBOC host analog audio if allowed by the test station. Moreover, during the DAB-off condition, the interfering station shall have full, 10 kHz modulation audio bandwidth. If DAB-off is executed for *both* 4.5 kHz and 10 kHz undesired host audio bandwidth, then the testing cycle will be 30 seconds of DAB-on, 30 seconds of 4.5 kHz DAB-off and 30 seconds of 10 kHz DAB-off per condition and executed for ten, complete cycles. If required, extra steps for mode switching may be added to the test cycle and noted in the test documentation. The test operator must carefully record DAB-on/off timing and the associated transmission mode.

5.4.2.2 2nd Adjacent Channel Compatibility

WTOP, WWJ and KABL have proximal 2nd adjacent stations appropriate for compatibility testing. Adjacent channel compatibility tests shall be executed for all station that are 2nd adjacent channels to these IBOC test stations and have programming appropriate for subjective testing. The 2nd adjacent channel compatibility tests shall use the methodology of the 1st adjacent channel compatibility tests, including the same interference ratios and DAB-on/off cycles.

5.4.2.3 3rd Adjacent Channel Compatibility

If possible, adjacent channel compatibility tests will be done for 3rd adjacents to WTOP and KABL. The general procedure is similar to that for 1st adjacent channel compatibility.

5.4.3 Host Compatibility and Adjacent Channel Compatibility Test Receivers

The NRSC list of analog test receivers appears on the last page of the IBOC Field Test Procedures – AM Band. The host and adjacent channel compatibility receivers are:

- Delphi PN 09394139 original equipment automobile receiver
- Pioneer model KEH-1900 aftermarket automobile receiver
- Technics model SA-EX140 home hi-fi receiver
- Sony model CFD-S22 portable receiver

All receivers with antenna port connections shall be connected to the mobile test platform antennas for compatibility measurement.

6. Data Handling

6.1 File naming conventions

Data files, loose document pages and digital audiotapes shall be named using the formats shown below. It is important to adhere to these conventions in order to facilitate data cataloging, file sorting and user recognition of file contents.

6.1.1 Data Files

Data files created by *The Collector* DAQ application shall be named using the form

AAAABBBCDDEEE.txt

Where,

AAAA = The digital transmitting station's call letters
BBB = the route radial designation in degrees, or an alternative alpha-numeric abbreviation descriptive of the route
C = "a" for the first segment of a radial drive, "b" for the second segment of a radial drive and so on.
DD = a numeric designator indicating the number of re-drives of a radial. "00" for the first, "01" for the second and …
EEE = "" for original direction of drive for a radial. "REV" for the reverse drive of a radial

6.1.2 PC File Storage – Disks, Tapes and Cartridges

6.1.2.1 File Storage Disks

The test team will use Iomega ZipDisks and/or CD-R disks for data archival and backup. One 250 MB ZipDisk should be capable of holding the data file contents of one, entire test segment, including flat data files from the DAQ PC, JPG camera images, spectrum analyzer images and text files of engineering comments. The naming convention for backup disks shall be of the form

AAAA-BBBBMMYY-CC/DD-EEEEEEE

Where,

AAAA = the text "*NRSC"*
BBBB = the test segment station's call letters
MM = the two digit designation of the month in which the test segment began
YY = the two digit designation of the year in which the test segment began
CC/DD = is the numerical indication of the volume number CC in a total set of DD disks for the test segment.
EEEEEEE = "ARCHIVE" or "COPYXYZ" as appropriate to indicate whether the disk is the official archive unit or a copy, where XYZ is the number of the copy

For example, the second of three archival disks for the test data from the KABL segment, which began testing in August of 2001, would be:

NRSC-KABL0801-02/03-ARCHIVE

6.1.3 MDM Multi-track Tapes

Digital audiotapes – either from the DA-98 or any other DAT or multi-track device will be labeled using the form

AAAABBBCDDEEE

Where,

AAAA = The digital transmitting station's call letters
BBB = the radial designation in degrees
C = "a" for the first segment of a radial drive, "b" for the second segment of a radial drive and so on.
DD = a numeric designator indicating the number of re-drives of a radial. "00" for the first, "01" for the second and so on
EEE = "" for original direction of drive for a radial. "REV" for the reverse drive of a radial

In addition, all tapes will bear a pre-printed label (supplied by tape manufacturer) indicating whether the tape is a MASTER (the original recording), a SAFETY copy or simply a COPY.

6.1.4 Hardcopy

Hardcopy plots from the spectrum analyzer or other image-generating device will be labeled using the form

AAAABBCCCDEEE

Where,

AAAA = The test segment's digital transmitting station's call letters
BB = the two digit number of the day of the month in which the plot was made
CCC= the three letter alpha abbreviation for the month in which the plot was made
D = is the alpha character to indicate the test campaign set, "A" for the first, "B" for the second series (e.g., re-test) and so on
EEE = a numeric designator indicating the sequence number for the plot in the test segment

For example, the thirty-seventh plot in the first measurement campaign of KABL, made on the 11th of August would be designated:

KABL11AUGA037

Since the plot designation in no way describes the contents or the conditions under which a plot is made, it is vital that a description of each plot and similar hardcopy be entered into the Test Segment Notebook along with its identifying label.

6.1.5 Miscellaneous

Miscellaneous data in formats not described above shall be labeled in the following manner:

AAAABBBBBCCDDDEFFF

Where,

AAAA = The test segment's digital transmitting station's call letters
BBBBB = is a five character description of the data format, e.g., *NOTES* or *PHOTO*
CC = the two digit number of the day of the month in which the plot was made

DDD= the three letter alpha abbreviation for the month in which the plot was made
E = is the alpha character to indicate the test campaign set, “A” for the first, “B” for the second series (e.g., re-test) and so on
FFF = a numeric designator indicating the sequence number for the plot in the test segment

6.2 Data Delivery, Archival and Reporting

6.2.1 Data Backup Requirements

6.2.1.1 Daily

At the end of each testing day, the test team will copy all new data to a safety backup ZipDisk. This disk will become the archival disk at the end of the segment. If possible, all new data also will be copied to the iBiquity server in the folder designated by test management. It is also recommended that the test log, any hardcopy and the new entry pages in the Test Segment Notebook be copied for backup.

6.2.1.2 End of Test Segment

At the conclusion of each test segment all PC file-based test data shall be completely archived on either ZipDisk or CD-R. The first such copy will be designated the *Archive Copy*.

All digital audio recordings will be duplicated at least once. Digital audio duplications only may be done as direct digital-to-digital dubs (recordings) from MDM digital tape to any of these

- MDM digital tape
- CD-R
- Network Drive

For storage of digital audio on CD-R or network drive, each track of the original MDM tape must first be converted to a Windows *.WAV format 16-bit PCM audio file. This conversion must be done using a TASCAM TDIF PC interface card. The TDIF card permits direct transfer of the DA-98’s 16-bit, linear audio data to PC using a multitrack digital audio editing program. Cool Edit Pro is recommended for this purpose. The sample rate of the audio file shall be the same as the source (usually 44.1 kHz).

The original MDM recording shall be designated the *MASTER*. All copies of the MASTER will be designated as *SAFETY COPY*. Documentation must accompany all *.WAV file backups of MDM tapes identifying the file associations to original tapes, indexing *.WAV start times with the corresponding MDM SMPTE start times. A Cool Edit multi-track session file and information linking related *.WAV files also shall be created and documented. *.WAV files shall be names to reflect their source MDM tape and respective track number.

All other records shall be copied by appropriate reproduction methods to create safety copies.

6.2.2 Data Distribution and Delivery

At the end of each test segment, iBiquity's senior test team member will receive a complete set of the test segment data for delivery to either the field test Engineering Manager or the field test Program Manager. All original copies of data will be hand-carried back to iBiquity's offices. ***No original data shall be transported by any means other than hand carrying.*** Only data that are securely archived may be mailed, express mailed or similarly transported.

7. Field Test Personnel

7.1 Engineering Manager

iBiquity's field test Engineering Manager is responsible for overall technical and administrative aspects of the test program. The Engineering Manager is Greg Nease.

7.2 Program Manager

iBiquity's field test Program Manager is responsible for test program tracking and scheduling, as well as, management of in-field measurements. The Program Manager reports to the Engineering Manager. The Program Manager is Russ Mundschenk.

7.3 NRSC Observer

The NRSC provides an observer for each Hybrid AM field test. The NRSC has arranged for these to be provided through two, broadcast-industry consulting firms. Alan Rosner of Denny & Associates and Stan Salek of Hammett & Edison shall be contacted to coordinate testing and observation. In the event of scheduling difficulties, the Supervising Engineer should contact David Layer, Director of Advanced Engineering at the NAB.

7.4 Supervising Engineers

All field test teams must include at least one iBiquity Supervising Engineer to oversee and execute testing. Supervising Engineers are familiar with both broadcast and receiver aspects of digital and analog systems. Supervising Engineers report to the Engineering Manager. Pat Malley and Tom Walker are the Supervising Engineers.

7.5 Test Engineers

iBiquity Test Engineers report to the Supervising Engineers. Test Engineers execute technical procedures under the guidance of the Supervising Engineers and Auditors. Test Engineers specialize in testing, configuration and maintenance of the digital receivers and/or the mobile test platform. Test Engineers are Kenneth Brockel and Keith Ege.

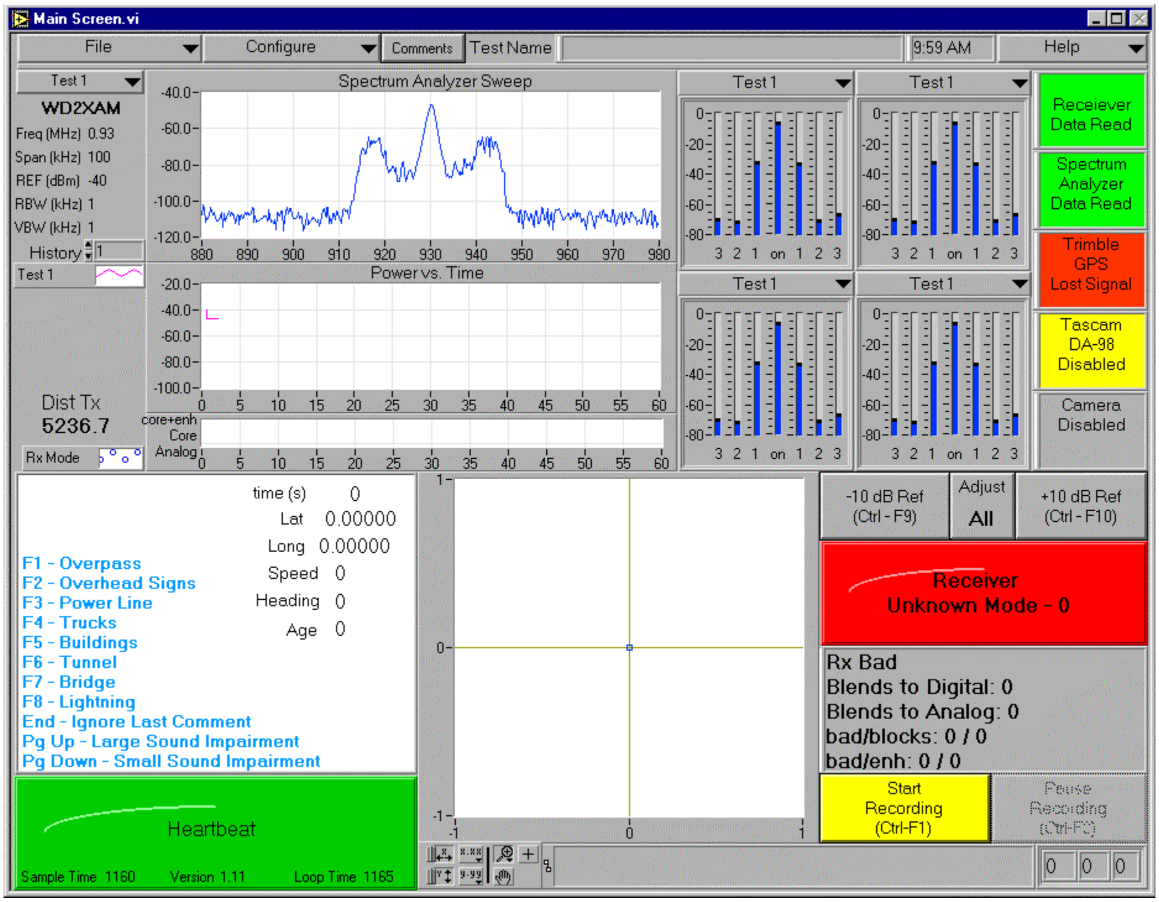
8. Procedural Deviations

As occurs in nearly every test program, the need for deviation from a prescribed procedure will arise. Any prospective deviations from procedure shall be reported to the field test Engineering Manager for consideration. In the absence of the Engineering Manager, prospective deviations shall be reported to the Program Manager. With the advice of the NRSC Observer, the Engineering and/or Program Manager shall decide whether a prospective procedural deviation may be authorized in the field by iBiquity field test management, or must be referred to the NRSC DAB Subcommittee's Steering Committee for consideration. In the latter case, the Engineering Manager or iBiquity senior management team will present the prospective deviation before the Steering Committee.

For all changes and prospective changes to procedure, the test team shall document the deviation in full detail plus the decision process leading to the authorization of the procedural change.

9. Attachments

Attachment A: *The Collector* Graphical User Interface – The Main Screen



Attachment B: EMI Remediation Notes

While there are many reasons and many solutions to eliminating EMI, the choices of remediation in the field are usually few. These include

- removal and/or replacement of the offender with a better behaved equivalent
- addition of ferrite EMI suppression devices on interface and power cables
- better shielding, grounding and/or bonding of device cases
- insertion of in-line EMI suppression filters on interface and power cables
- changes in placement of equipment
- changes to equipment operational and/or interface modes that will shut-down or alter internal clock or oscillator generation.

The order in which the above approaches are listed represents the more likely and effective solutions. It is often very helpful to have an experienced RF engineer on hand to assist in EMI reduction procedures.

Three more important points on this topic:

- Every test segment will require dedicated EMI testing, as an interferer will not affect every part of the AM band equally. It is not sufficient to check another, nearby AM channel for interference and assume the same situation will exist on the test segment's desired channel.
- Do not overlook the test receivers as possible sources of interference.
- Monitoring for interference in a receiver's IF signal path is the easiest and most sensitive way to observe EMI. However, detection of interference at IF is not a positive indication of EMI, as other interference mechanisms such as intermodulation and front-end spurious responses may produce similar effects.

Not all EMI problems can be solved easily. Some solutions may require creative or radical changes to the test configuration. Be prepared to face this situation. What work for one test segment may not work for another. Again, having an experienced RF engineer on hand to help evaluate and solve EMI issues may be critical to success.

Attachment C: Candidate Stations for Adjacent Channel Compatibility Tests

IBOC Station	Test Station	Frequency (kHz)	Adjacency 1st	2nd	3rd	Program Format
KABL	KAHI	950	X			Jammin' Juke Box 50s - 70s
960 kHz	KANM	970	X			Sports
	KCTY	980		X		Regional Mexican
	KATD	990			X	Talk & Sports
WTOP	WARK	1490	X			Oldies
1500 kHz	WLPA	1490	X			Sports/Talk
	WWSM	1510	X			Country
	WCVA	1490	X			Country
	WNNN	1510	X			Christian
	WVFC	1480		X		Christian/News
	WTRI	1520		X		Oldies
	WPWC	1480		X		Country/Gospel
	WCHE	1520		X		Talk
	WDAS	1480		X		Gospel
	WSHP	1480		X		Oldies
	WISL	1480		X		Oldies
	WJDY	1470			X	
	WCTR	1530			X	Talk/farm/adult standards
	WTTR	1470			X	Soft AC/News/Talk
WWJ	WBCK	930		X		News/Talk
950 kHz	WKHM	970		X		News/Talk
	WEOL	930		X		News/Sports
WD2XAM	WJNZ	1680		X		Urban/AC
1660 kHz	WLHJ	1640		X		
	WHTE	1690			X	Construction Permit